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SOME FEATURES DURING PRODUCTION OF PRODUCTS USING HOT ISOSTATIC PRESSING

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Keywords: powder metallurgy, hot isostatic pressing, pressure, heating.
Abstract. The traditional variant of producing cast products for various purposes is accompanied by the presence of defects in castings, such as: shrinkage porosity, gas saturation, discontinuity (dislocations), and others. In this regard, a demand has arisen for the use of additive technologies as an alternative to traditional technological methods for the production of products. The main advantage, which is not only the way to obtain a product with improved properties, but also economic feasibility. A known method for improving the quality of the finished product structure is hot isostatic pressing (HIP). The use of isostatic pressing is used to produce complex workpieces with a denser and more uniform structure than compaction in any other way. The complexity of the HIP process lies in the many thermal, physical and mechanical interactions and the influence of a large number of parameters on them. Through the correct understanding and management of these factors, as well as the use of additive technologies, it is possible to obtain materials in quality that are not inferior to materials obtained by traditional production methods.

О НЕКОТОРЫХ ОСОБЕННОСТЯХ ПРИ ПРОИЗВОДСТВЕ ИЗДЕЛИЙ С ПРИМЕНЕНИЕМ ГОРЯЧЕГО ИЗОСТАТИЧЕСКОГО ПРЕССОВАНИЯ

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Ключевые слова: порошковая металлургия, горячее изостатическое прессование, давление, нагрев.
Аннотация. Традиционный вариант получения литых изделий различного назначения сопровождается наличием в отливках дефектов, таких как: усадочная пористость, газонасыщенность, несплошность (дислокации) и другие. В связи с этим, возник спрос на использование аддитивных технологий в качестве альтернативы традиционным технологическим методам для производства изделий. Главным преимуществом, которого, является не только способ получения изделия с улучшенными свойствами, но и экономическая целесообразность. Известным способом повышением качества структуры готового изделия является горячее изостатическое прессование (ГИП). Применение изостатического прессование используется для производства комплексных заготовок с более плотной и равномерной структурой, чем при компактировании другим способом. Сложность процесса ГИП заключается во многих тепловых, физических и механических взаимодействиях и влиянии на них большого количества параметров. Путем правильного понимания и управления этими факторами, а также применением аддитивных технологий можно получать материалы по качеству, не уступающие материалам полученным традиционными способами производства.

Abroad, the GIP technology is widely used in various branches of technology. In the 60s of the XX century, with the use of HIP, the production of synthetic diamonds, elements of nuclear fuel, products from beryllium powders and sintered carbides was created. Then HIP began to be used in the production of powder high-speed and die steels, in the form of blanks for subsequent forging and rolling, as well as in the production of shaped products from heat-resistant nickel and cobalt alloys. In the 1980s, work began on the manufacture of workpieces by the HIP

method, similar in shape to finished products, from stainless steel and titanium powders [1].

Processing technology is one of the most advanced and demanded on the modern market. This is easily explained by the fact that the pressing method has undeniable advantages in comparison with the methods of processing products with the help of pressure and temperature that have already been used for a long time. In addition, the accelerated pace of development of pressure equipment is also driving the active adoption of the technology.

The workpiece is placed in a shell that takes on the required elasticity when exposed to high temperatures, such as glass or metal. The workpiece is under operating pressure through an intermediate medium (most often gas). The furnace is placed in a so-called gas-stat, which is a high-strength shell that withstands a gas pressure of up to 200 MPa during sintering. This is the technical problem. In the process of increasing temperatures, the degree of thermal conductivity of the gas medium also increases. In this case, the degree of strength of the material from which the body is made decreases.

The HIP method is one of the methods of compacting metal powders by applying high isotropic pressure at high temperatures below the melting point of the material.

The main issues when considering the method of hot isostatic pressing in production include:

- economic benefits when using powder metallurgy and hot isostatic pressing (HIP) method instead of traditional methods;
- will there be an improvement in product quality after applying the hot isostatic pressing method;
- are there new opportunities for the development of high-temperature components using the HIP method;
- whether the use of the GUI method will reduce the cost of processing parts;
- whether costs will be reduced as a result of material loss during processing.

Spherical powders made of various metal alloys are most often used for HIP. Capsules are thin-walled shells similar in shape to pressed products. Such products can have both simple shapes of a cylindrical or flat ingot for subsequent forging and rolling, and complex shapes of shaped parts that do not require additional deformation. Typically, capsules are made from well weldable low carbon steel sheet [2].

When studying the characteristics before and after using the HIP, it was found that in the coating layer in the initial state, pores with a size of up to 8 μm are observed. The use of HIP reduces the maximum pore size to – 1.5 μm, while fine porosity of <0.5 μm is completely healed. The absence of pores and microcracks in the area of the protective coating with the help of HIP, an increase in the adhesion of the coating to the workpiece is accompanied by an improvement in the fatigue strength of the finished product.

In this regard, the advantages of hot isostatic pressing include:

1) The finished product retains a fine-grained crystal structure.

2) An increased rate of cooling of the processed part is achieved, which allows quenching, achieved by a high thermal conductivity of the gas.

3) Eliminates the occurrence of inhomogeneity, which is characteristic of castings in ordinary casting due to the long cooling time of the layers.

4) Shrinkage and the development of cracks in the internal structure that arise during cooling of metals are excluded.

5) There is no porosity, which significantly worsens the quality of machining, the wear resistance increases, the degree of friction during the operation of the elements decreases.

6) The metal can acquire properties that previously could be transferred only under deformation effects.

7) Improves resistance to gas pressure at the points of welded joints and the elimination of areas prone to corrosion

8) Microcracks typical for restoration operations are removed.

Thanks to hot isostatic pressing, various customary technological procedures are optimized, products can be produced that cannot be manufactured by other methods. Therefore, hot isostatic pressing is one of the most promising directions in the processing of metals, powders and ceramics [3].

Traditional technologies for producing products in foundry have a rather long duration and laboriousness of the process, but with the use of HIP technology, high-quality products with a mass with improved properties can be obtained. In this regard, on the basis of PJSC Ruspolymet, a project has been developed for the creation of an import-substituting production of blanks from metal powders based on industrial technology of hot isostatic pressing using additive technologies.

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